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Ishibashi et al.

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(54) **GLASS PANEL UNIT AND INSPECTION METHOD THEREOF**

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CPC ***G01M 3/02*** (2013.01); ***C03C 27/06*** (2013.01); ***G01L 21/00*** (2013.01); ***G01N 7/04*** (2013.01); ***G01N 21/783*** (2013.01)

(58) **Field of Classification Search**
CPC G01L 21/00; G01M 3/02; G01N 21/78; G01N 21/783; G01N 7/04; C03C 27/06
(Continued)

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(57) **ABSTRACT**

The glass panel unit includes: a first glass panel; a second glass panel; a seal; an evacuated space; and a gas adsorbent. The seal with a frame shape hermetically bonds the first glass panel and the second glass panel to each other. The gas adsorbent is placed in the evacuated space. The gas adsorbent includes a getter. The gas adsorbent is visible through

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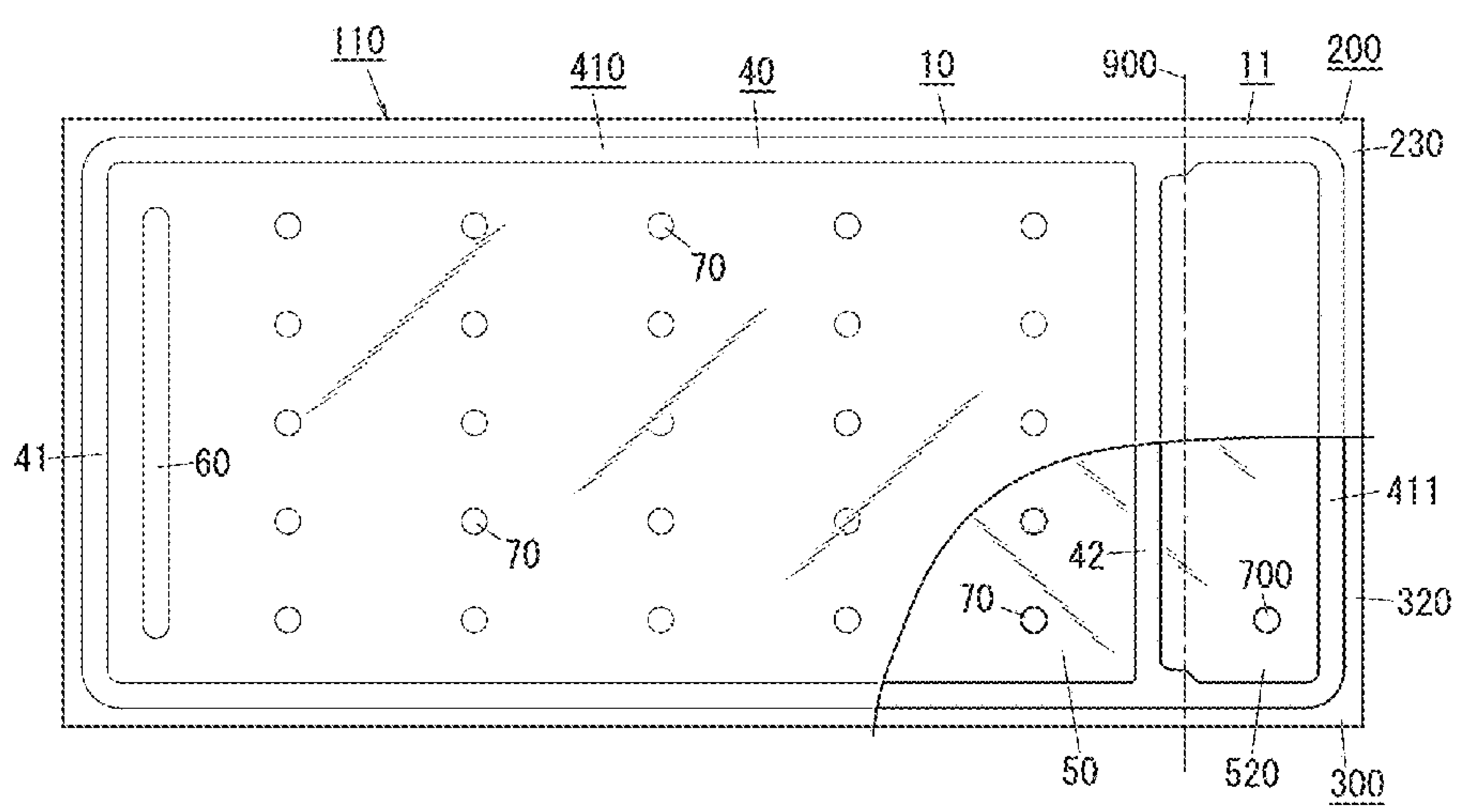

at least one of the first glass panel and the second glass panel. The gas adsorbent has properties of changing its color when adsorbing gas.

2 Claims, 10 Drawing Sheets

(51) **Int. Cl.**
C03C 27/06 (2006.01)
G01N 7/04 (2006.01)
G01L 21/00 (2006.01)

(58) **Field of Classification Search**
USPC 436/2, 3, 72, 73, 80, 164, 165, 167, 181; 422/400, 401, 402, 86, 88, 547, 554
See application file for complete search history.

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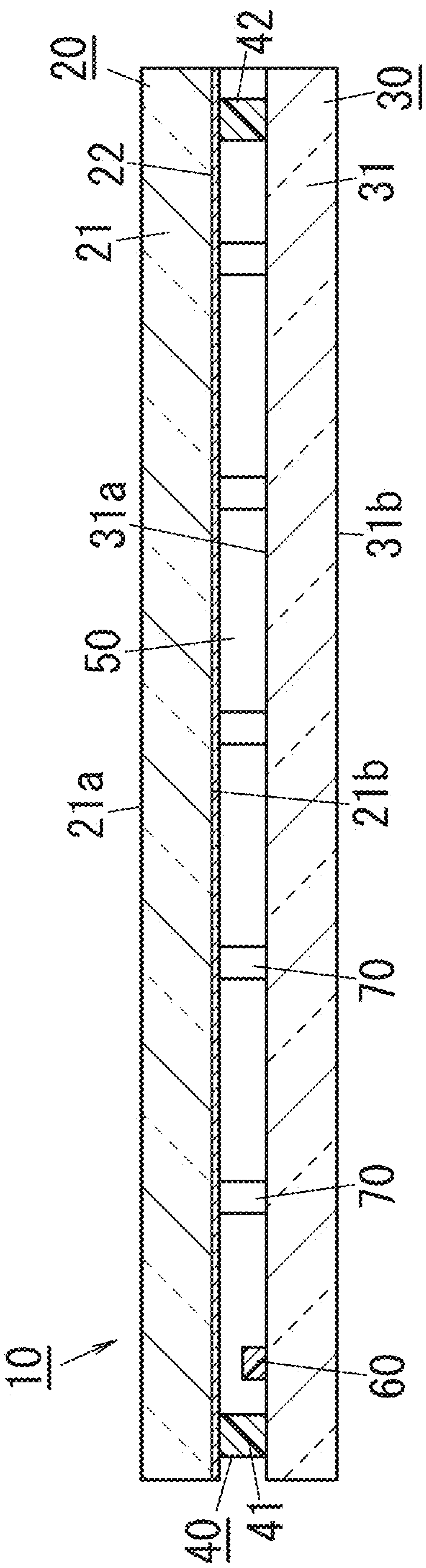


FIG. 1

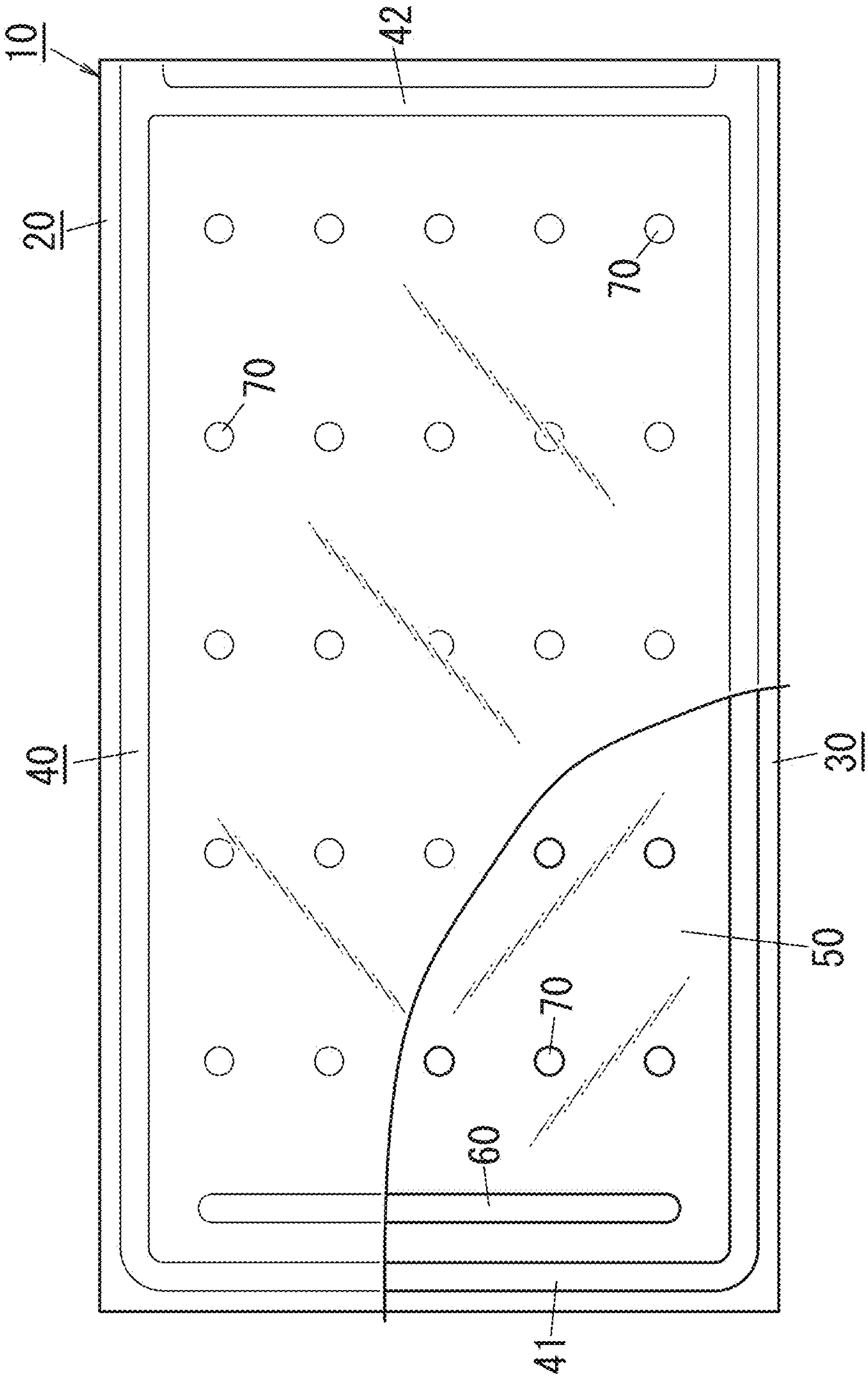


FIG. 2

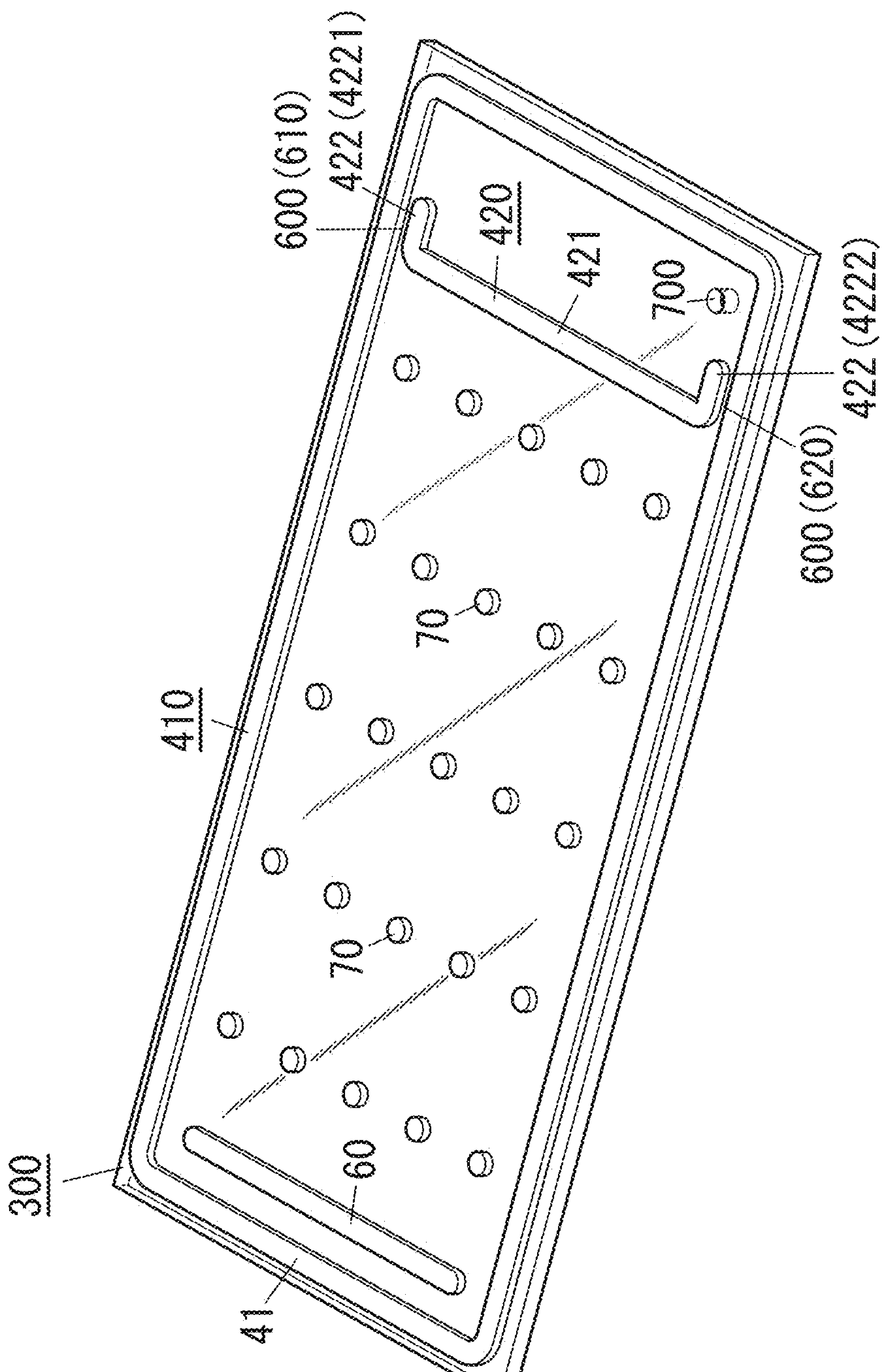


FIG. 3

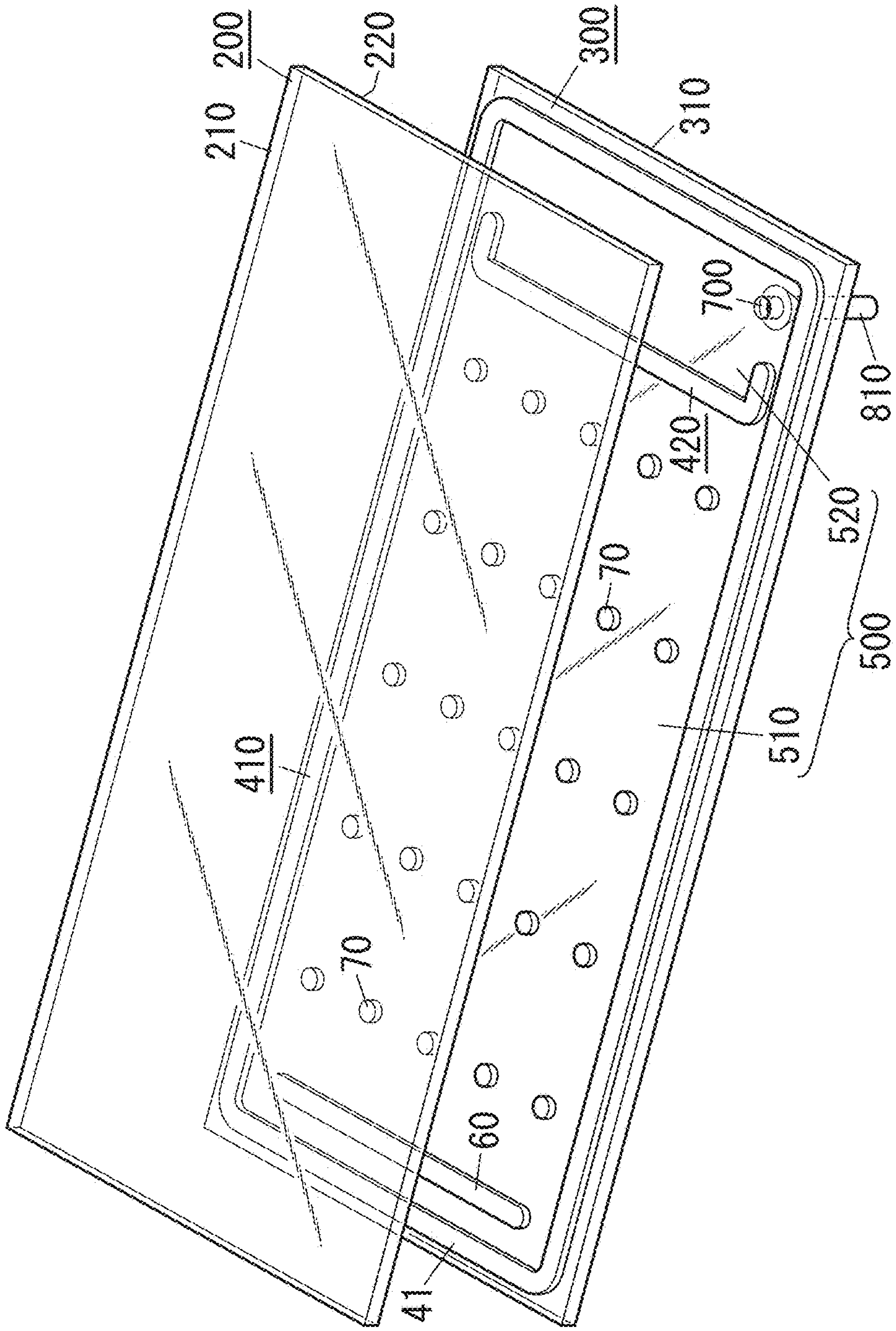


FIG. 4

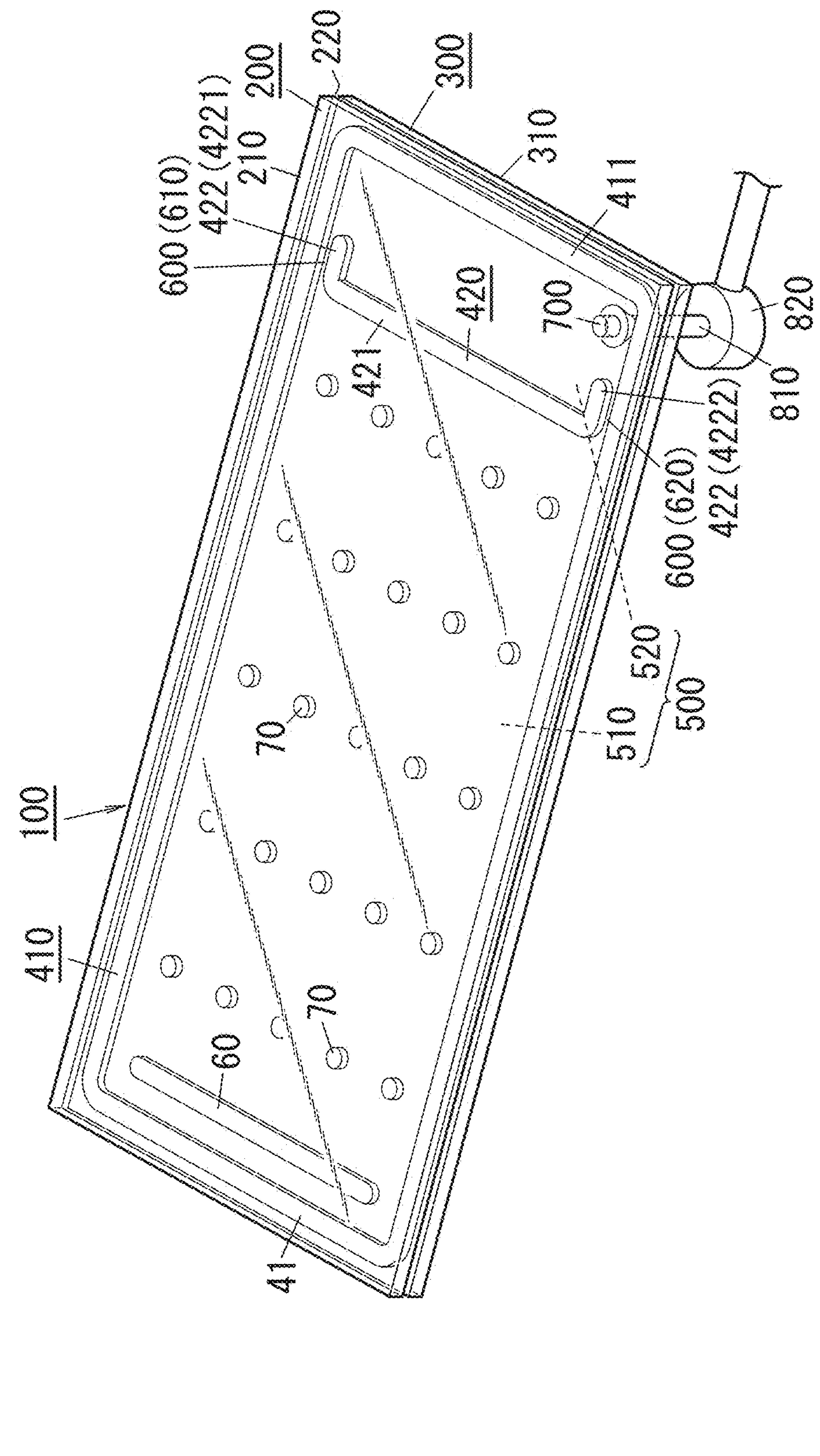

220
200
300
422 (4221)
210
310
600 (610)
411
420
700
820
421
810
422 (4222)
600 (620)
520
510
500
70
100
410
70
60
41

FIG. 5

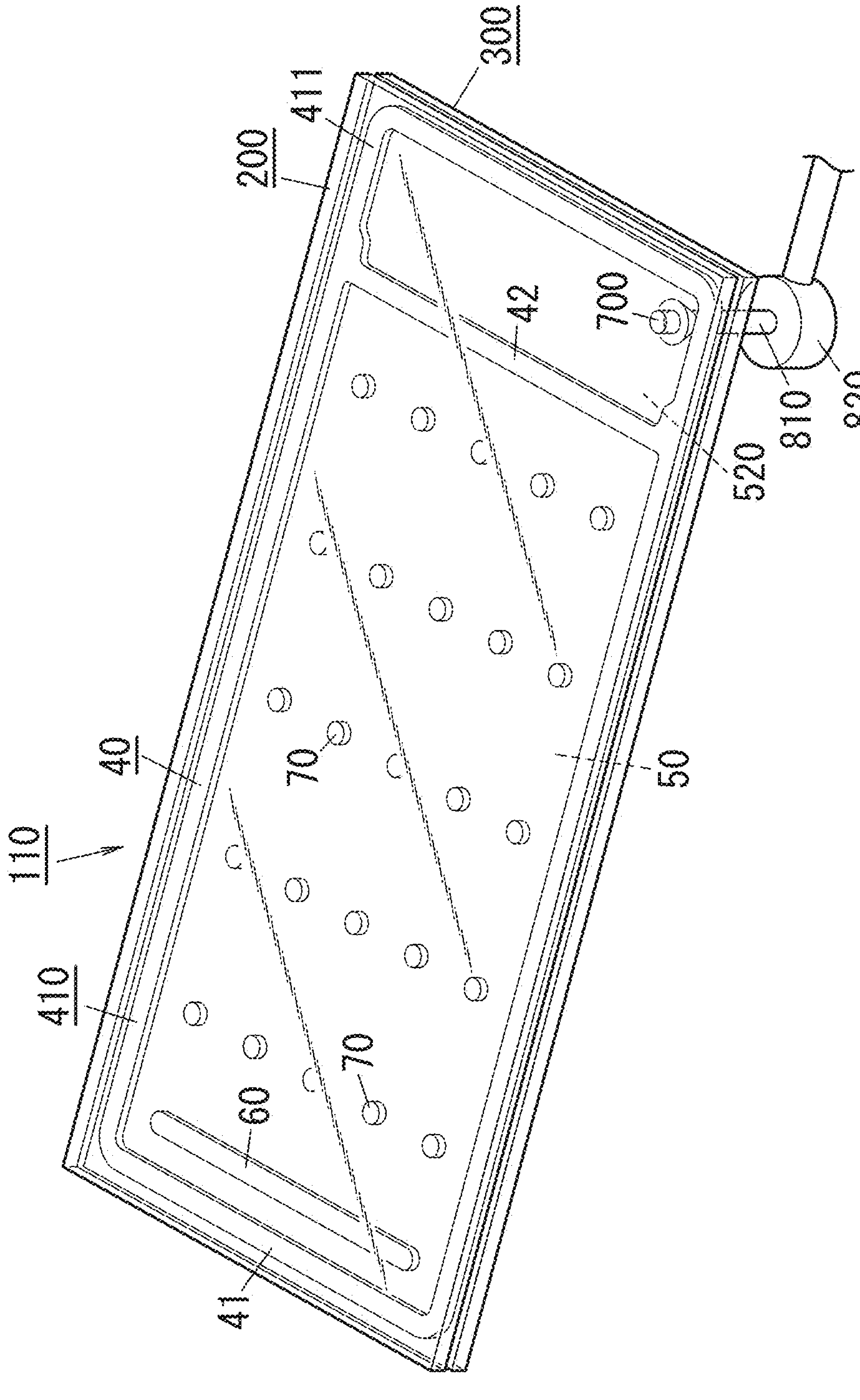


FIG. 6

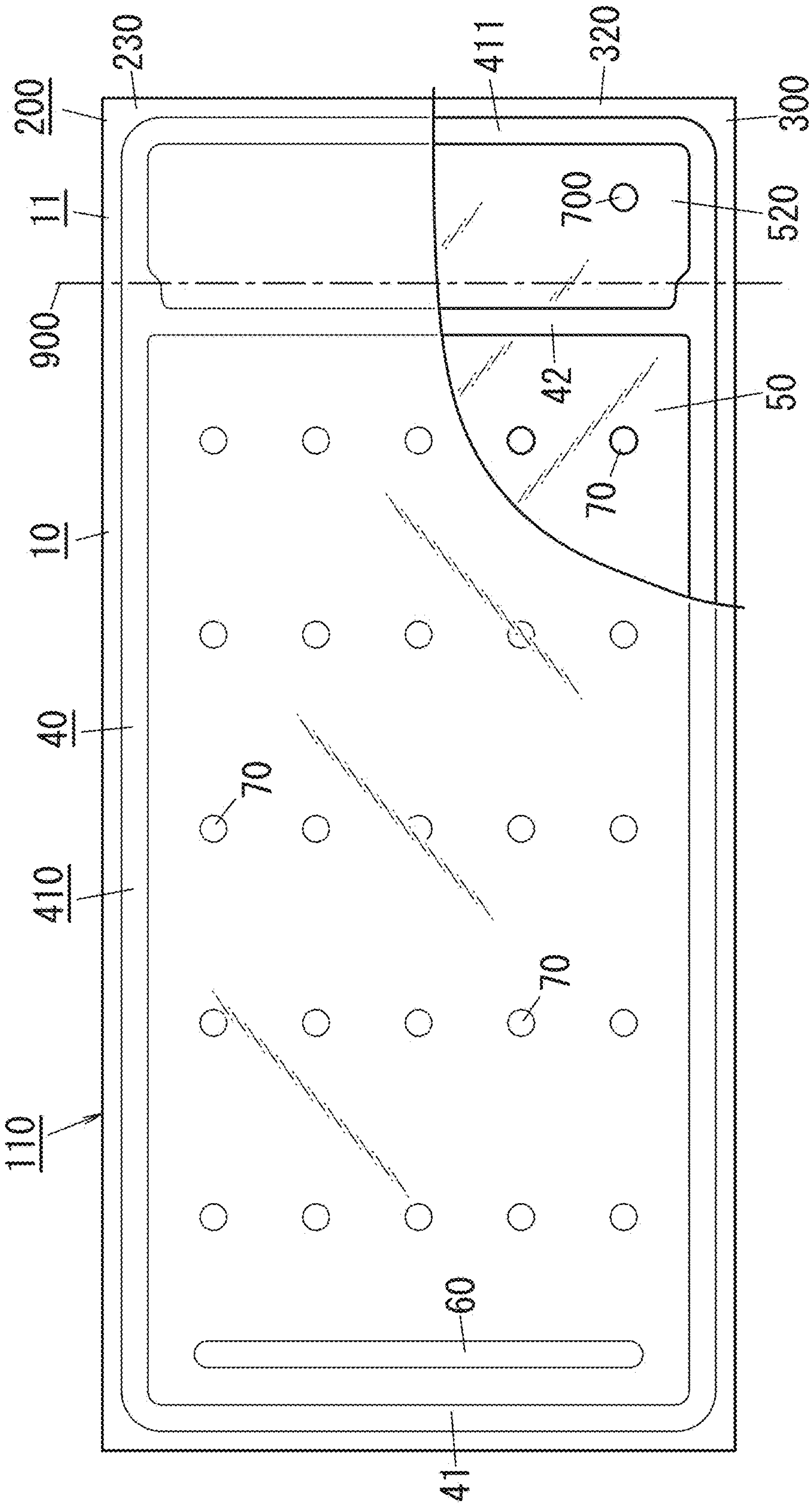

200
230
411
320
300
11
700
520
900
42
50
10
70
40
410
70
70
110
60
41

FIG. 7

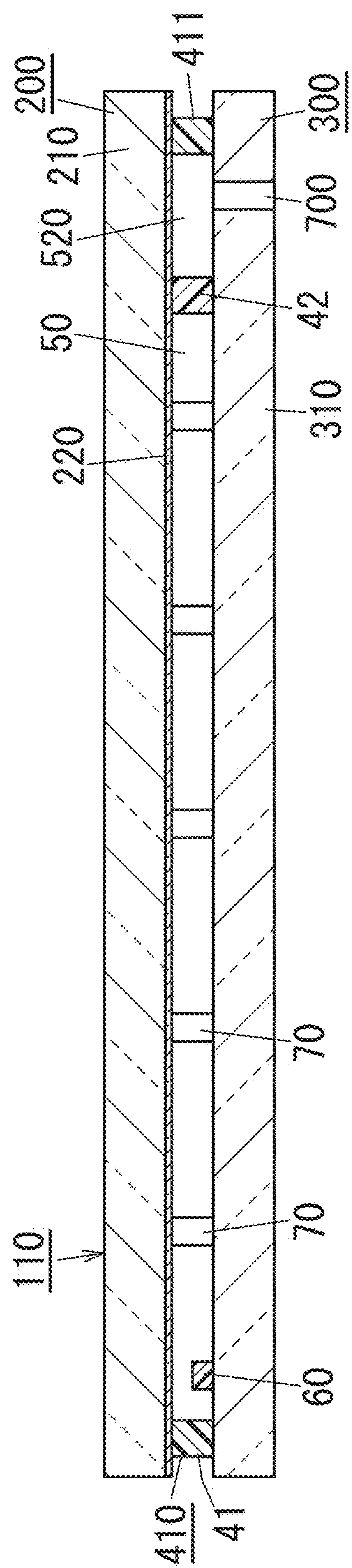


FIG. 8

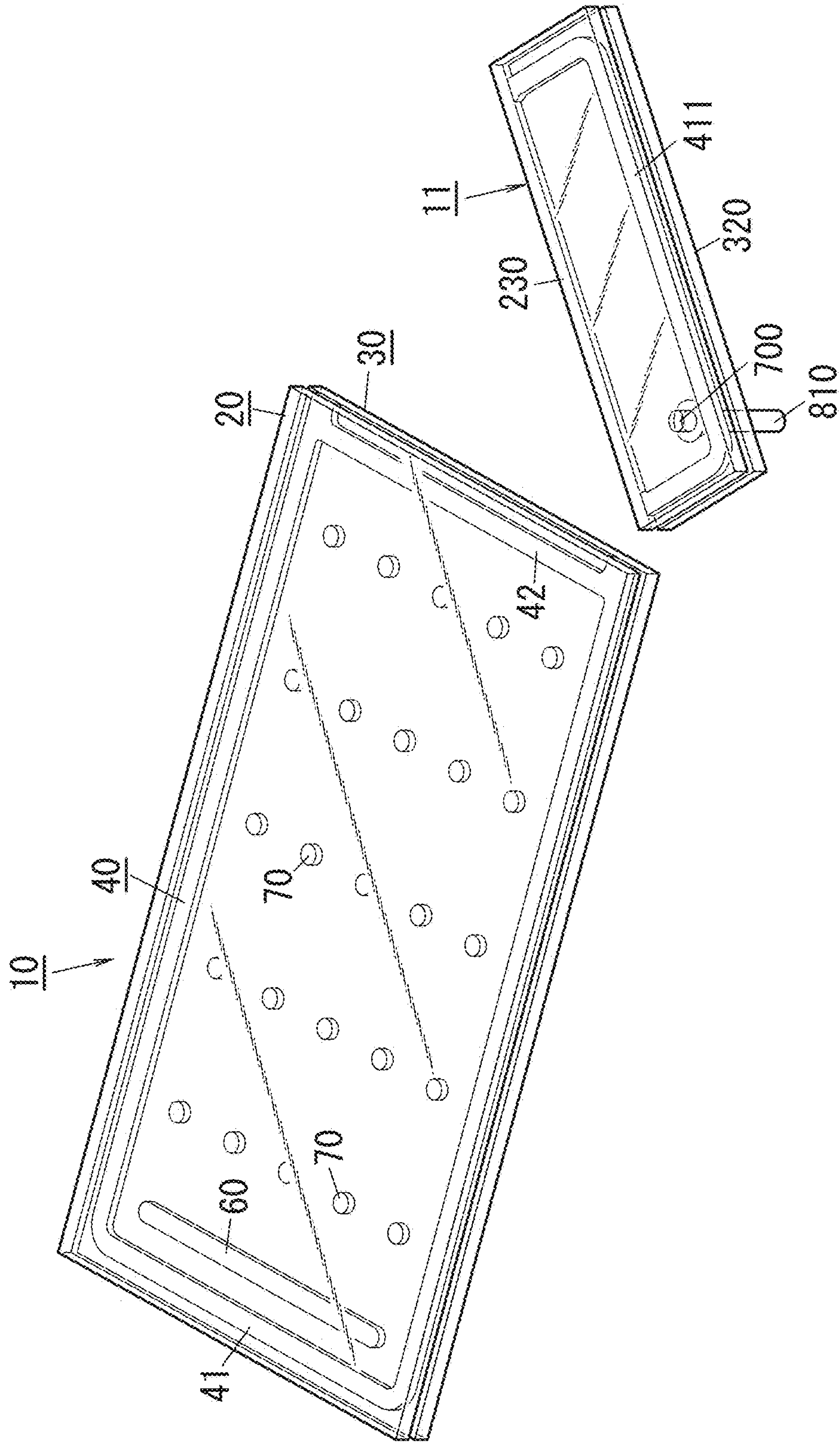
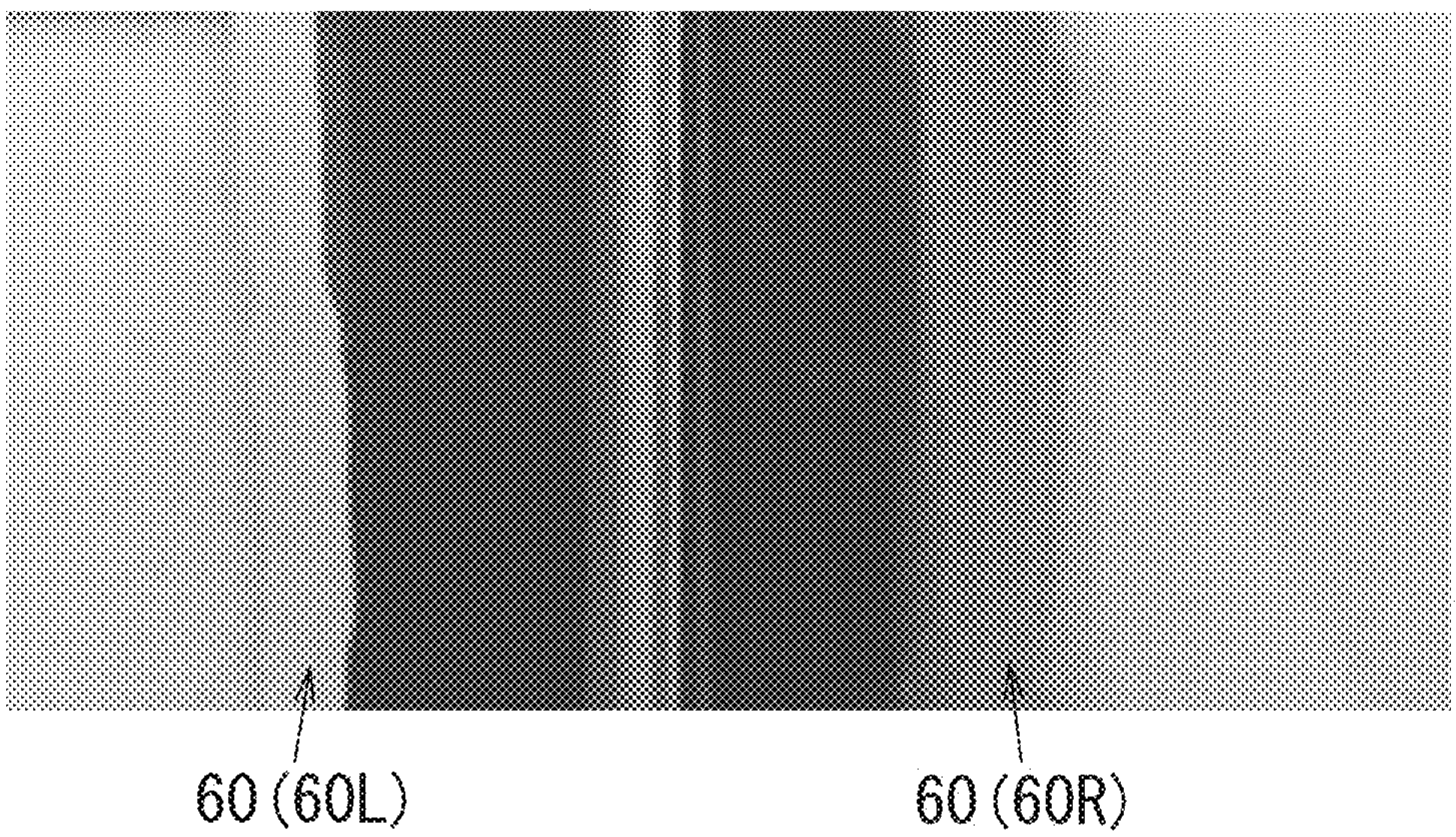


FIG. 9

FIG. 10



GLASS PANEL UNIT AND INSPECTION METHOD THEREOF

RELATED APPLICATIONS

This application is the U.S. National Phase under 35 U.S.C. § 371 of International Patent Application No. PCT/JP2015/004775, filed on Sep. 17, 2015, which in turn claims the benefit of Japanese Application No. 2014-200975, filed on Sep. 30, 2014, the disclosures of which Applications are incorporated by reference herein.

TECHNICAL FIELD

The present disclosure relates to a glass panel unit and an inspection method thereof. In particular, the glass panel unit includes an evacuated space between a pair of glass panels.

BACKGROUND ART

There has been known a glass panel unit in which two or more glass panels are stacked with one or more gaps in-between to form one or more hermetically enclosed spaces, and the spaces are made to be in a vacuum state. This type of glass panel unit is also referred to as a multiple glass panel. This glass panel unit has high thermal insulating properties. It is important that the glass panel unit keeps the vacuum state.

There has been proposed use of a getter to maintain the vacuum state of the glass panel unit. The getter is a substance capable of adsorbing gas. For example, JP 2013-514245 A (WO 2011/072646 A1) discloses techniques of using stacked glass plates with different sizes and providing the getter on a periphery of one glass plate which is not covered with the other. However, according to the techniques of the document, the getter protrudes laterally, and this may lead to a poor appearance and a decrease in handleability.

SUMMARY OF INVENTION

An objective of the present disclosure would be to propose a glass panel unit maintaining a vacuum state and an inspection method thereof.

The glass panel unit of the present disclosure includes: a first glass panel; a second glass panel; a seal; an evacuated space; and a gas adsorbent. The second glass panel is placed opposite the first glass panel. The seal with a frame shape is placed between the first glass panel and the second glass panel to hermetically bond the first glass panel and the second glass panel to each other. The evacuated space is enclosed by the first glass panel, the second glass panel, and the seal. The gas adsorbent is placed in the evacuated space and including a getter. The gas adsorbent is visible through at least one of the first glass panel and the second glass panel. The gas adsorbent has properties of changing its color when adsorbing gas.

The inspection method of glass panel unit of the present disclosure includes determining a degree of vacuum of the evacuated space based on change in color of the gas adsorbent.

The glass panel unit of the present disclosure allows easily determining the degree of vacuum of the evacuated space based on change in the color. Therefore, it is possible to check whether the vacuum state is maintained, and therefore the glass panel unit maintaining the vacuum state can be provided.

The inspection method of glass panel unit of the present disclosure allows easily determining the degree of vacuum of the evacuated space based on change in the color. Therefore, it is possible to check whether the vacuum state is maintained, and therefore the glass panel unit maintaining the vacuum state can be provided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic section of the glass panel unit of one example.

FIG. **2** is a schematic plan of the glass panel unit of the example.

FIG. **3** is a perspective view of the glass panel unit at a step of a method for manufacturing the same thereof.

FIG. **4** is a perspective view of the glass panel unit at another step of the method for manufacturing the same.

FIG. **5** is a perspective view of the glass panel unit at another step of the method for manufacturing the same.

FIG. **6** is a perspective view of the glass panel unit at another step of the method for manufacturing the same.

FIG. **7** is a schematic plan of the completed assembly of the glass panel unit.

FIG. **8** is a schematic section of the completed assembly of the glass panel unit.

FIG. **9** is a perspective view of the glass panel unit at another step of the method for manufacturing the same.

FIG. **10** is a photograph illustrating one example of change in color of the gas adsorbent.

DESCRIPTION OF EMBODIMENTS

FIG. **1** and FIG. **2** show a glass panel unit **10** of one embodiment. The glass panel unit **10** of the present embodiment is a vacuum insulated glass unit. The vacuum insulated glass unit is a type of multiple glass panels including at least one pair of glass panels, and includes an evacuated space **50** between the pair of glass panels. Note that, in FIG. **2**, to facilitate understanding of the internal structure only, the first glass panel **20** is illustrated with part (left and lower part) thereof being cutaway. Note that, directions (upward, downward, left, and right directions) in the figures are determined based on a direction of reference numbers in the same figures (a direction allowing reading the reference numbers).

The glass panel unit **10** includes the first glass panel **20**, a second glass panel **30**, a seal **40**, the evacuated space **50**, and a gas adsorbent **60**. The second glass panel **30** is placed opposite the first glass panel **20**. The seal **40** with a frame shape is placed between the first glass panel **20** and the second glass panel **30**. The seal **40** hermetically bonds the first glass panel **20** and the second glass panel **30** to each other. The evacuated space **50** is enclosed by the first glass panel **20**, the second glass panel **30**, and the seal **40**. The gas adsorbent **60** is placed in the evacuated space **50**. The gas adsorbent **60** includes a getter. The gas adsorbent **60** is visible through at least one of the first glass panel **20** and the second glass panel **30**. The gas adsorbent **60** has properties of changing its color when adsorbing gas.

The glass panel unit **10** allows easily determining the degree of vacuum of the evacuated space **50** based on change in the color. Therefore, it is possible to check whether the vacuum state is maintained, and therefore the glass panel unit **10** maintaining the vacuum state can be provided.

The first glass panel **20** includes a body **21** determining a plan shape of the first glass panel **20**, and a coating **22**. The body **21** is rectangular and includes a first face **21**_a_ (external face; upper face in FIG. **1**) and a second face **21**_b_ (internal face; lower face in FIG. **1**) in a thickness direction which are parallel to each other. Each of the first face **21**_a_ and the second face **21**_b_ of the body **21** is a flat face. Examples of material of the body **21** of the first glass panel **20** may include soda lime glass, high strain point glass, chemically strengthened glass, non-alkaline glass, quartz glass, neoceram, and physically strengthened glass. Note that, the first glass panel **20** may not include the coating **22**. The first glass panel **20** may be constituted by the body **21** only.

The coating **22** is formed on the second face **21**_b_ of the body **21**. The coating **22** may preferably be an infrared reflective film. Note that, the coating **22** is not limited to such an infrared reflective film but may be a film with desired physical properties.

The second glass panel **30** includes a body **31** determining a plan shape of the second glass panel **30**. The body **31** is rectangular and includes a first face **31**_a_ (internal face; lower face in FIG. **1**) and a second face **31**_b_ (external face; upper face in FIG. **1**) in a thickness direction which are parallel to each other. Each of the first face **31**_a_ and the second face **31**_b_ of the body **31** is a flat face. Examples of material of the body **31** of the second glass panel **30** may include soda lime glass, high strain point glass, chemically strengthened glass, non-alkaline glass, quartz glass, neoceram, and physically strengthened glass. The material of the body **31** may be same as the material of the body **21**. The body **31** has the same plan shape with the body **21**. Stated differently, the second glass panel **30** has the same plan shape with the first glass panel **20**.

The second glass panel **30** includes the body **31** only. In other words, the body **31** forms the second glass panel **30** by itself. The second glass panel **30** may include a coating. The coating may be formed on the first face of the body **31**. This coating may have properties same as the coating **22** of the first glass panel **20**.

The first glass panel **20** and the second glass panel **30** are arranged so that the second face **21**_b_ of the body **21** and the first face **31**_a_ of the body **31** face and parallel to each other. In other words, the first face **21**_a_ of the body **21** is directed outward from the glass panel unit **10**, and the second face **21**_b_ of the body **21** is directed inward of the glass panel unit **10**. Further, the first face **31**_a_ of the body **31** is directed inward of the glass panel unit **10**, and the second face **31**_b_ of the body **31** is directed outward from the glass panel unit **10**.

The seal **40** encloses the evacuated space **50** completely and bonds the first glass panel **20** and the second glass panel **30** to each other hermetically. The seal **40** has a rectangular frame shape. The evacuated space **50** has a degree of vacuum equal to or lower than a predetermined value. The predetermined value may be 0.1 Pa, for example. The evacuated space **50** may be formed by evacuation. The evacuation may include forming a hole for evacuation in at least one of the first glass panel **20**, the second glass panel **30**, and the seal **40** and removing gas from an inside. However, it is preferable that both the first glass panel **20** and the second glass panel **30** do not include any outlet by the following evacuation. In this case, it is possible to produce the glass panel unit **10** with an improved appearance.

The seal **40** is formed of thermal adhesive. Examples of the thermal adhesive may include glass frit. Examples of the glass frit may include low-melting-point glass frit. Examples of the low-melting-point glass frit may include bismuth-based glass frit, lead-based glass frit, and vanadium-based glass frit. The seal **40** may be made of multiple thermal adhesives, as described below.

As shown in FIG. **1** and FIG. **2**, the glass panel unit **10** further includes multiple spacers **70**. The multiple spacers **70** are used to keep a predetermined interval between the first glass panel **20** and the second glass panel **30**. The multiple spacers **70** allow reliably ensuring the space between the first glass panel **20** and the second glass panel **30**.

The multiple spacers **70** are placed inside the evacuated space **50**. In more detail, the multiple spacers **70** are placed at individual intersections of an imaginary rectangular lattice. For example, an interval between the multiple spacers **70** may be in a range of 1 to 10 cm, and in one example may be 2 cm. Note that, sizes of the spacers **70**, the number of spacers **70**, intervals between the spacers **70**, and pattern of arrangement of the spacers **70** may be appropriately determined.

Each spacer **70** has a solid cylindrical shape with a height almost equal to the aforementioned predetermined interval (interval between the first glass panel **20** and the second glass panel **30**). For example, each spacer **70** may have a diameter ranging from 0.1 to 10 mm and a height ranging from 10 to 1000 μm. In one example, each spacer **70** may have a diameter of 1 mm and a height of 100 μm. Note that, each spacer **70** may have a desired shape such as a solid prismatic shape and a spherical shape. The heights of the multiple spacers **70** determine the distance between the first glass panel **20** and the second glass panel **30** which means a thickness of the evacuated space **50**. The evacuated space **50** may have a thickness ranging from 10 to 1000 μm, and in one example may have a thickness of 100 μm.

Each spacer **70** is made of light-transmissive material. Thus, the multiple spacers **70** are unlikely to be perceived. Note that, each spacer **70** may be made of opaque material, providing that it is sufficiently small. Material of the spacers **70** is selected so that deformation of the spacers **70** does not occur during a first melting step, an evacuating step, and a second melting step which are described later. For example, the material of the spacers **70** is selected to have a softening point (softening temperature) higher than a first softening point of a first thermal adhesive and a second softening point of a second thermal adhesive.

The gas adsorbent **60** is placed inside the evacuated space **50**. In the present embodiment, the gas adsorbent **60** has an elongated shape. The gas adsorbent **60** is formed on a second end (left end in FIG. **2**) in the lengthwise direction of the second glass panel **30** to extend along the width direction of the second glass panel **30**. In summary, the gas adsorbent **60** is placed on one end of the evacuated space **50**. According to this arrangement, the gas adsorbent **60** can be unlikely to be perceived. In a case of directly placing the gas adsorbent **60** on a glass panel, placement of the gas adsorbent **60** can be facilitated. Note that, the gas adsorbent **60** may be provided in any position in the evacuated space **50**. For example, the gas adsorbent **60** may be provided to the second glass panel **30** likewise the present embodiment, or may be provided to the first glass panel **20**. Additionally, the gas adsorbent **60** may be in contact with the seal **40**. It is sufficient that the gas adsorbent **60** is placed visible from the outside.

The gas adsorbent **60** is used to adsorb unnecessary gas (for example, residual gas). The unnecessary gas may include gas emitted in forming the seal **40**. The unnecessary gas may further include gas intruding into an inside through a gap in the seal **40**. An increase in such gas may cause a decrease the degree of vacuum and thus a decrease in the thermal insulating properties.

The gas adsorbent **60** includes a getter. The getter is a substance having properties of adsorbing molecules smaller than a predetermined size. The getter may be an evaporative getter. The evaporative getter has properties of desorbing adsorbed molecules when having a temperature equal to or higher than a predetermined temperature (activation temperature). Therefore, even if the adsorbability of the evaporative getter has been decreased, the adsorbability of the evaporative getter can be recovered by heating the evaporative getter to a temperature equal to or higher than the activation temperature. Examples of the evaporative getter may include zeolite and ion-exchanged zeolite.

The gas adsorbent **60** includes a powder of this getter. In more detail, the gas adsorbent **60** may be formed by: applying a liquid containing a powder of the getter; and solidifying it. Examples of the liquid containing a powder of the getter may include dispersion liquid prepared by dispersing a powder of the getter in a liquid and a solution prepared by dissolving a powder of the getter in a liquid. In this case, the gas adsorbent **60** can be downsized. Therefore, the gas adsorbent **60** can be placed even if the evacuated space **50** is small.

The gas adsorbent **60** is visible through at least one of the first glass panel **20** and the second glass panel **30**. In FIG. **1** and FIG. **2**, the gas adsorbent **60** is visible through each of both the first glass panel **20** and the second glass panel **30**. As described above, the gas adsorbent **60** is visible and therefore it is possible to facilitate determining change in color. Such change in color can be checked through at least one of the first glass panel **20** and the second glass panel **30**.

The gas adsorbent **60** has properties of changing its color when adsorbing gas. Change in color of the getter may cause change in color of the gas adsorbent **60**. The gas adsorbent **60** may have such properties that the color changes gradually according to an amount of adsorbed gas. Or, the gas adsorbent **60** may have such properties that the color changes sharply when an amount of adsorbed gas reaches a predetermined amount. The color change can be observed by optical measurement. Examples of an index therefor may include a color difference and chromaticity. It is preferable that the color change can be observed with the naked eyes. Thereby, check of adsorption of gas can be facilitated.

The zeolite is particularly preferable for the getter. The zeolite is excellent in gas adsorption properties. Further, the zeolite may include multiple fine pores. Such multiple fine pores may cause an increase in the surface area. The multiple fine pores can take in gas. The zeolite with multiple fine pores tends to show high gas adsorption properties.

The zeolite has a three-dimensional structure where silicon (Si) and aluminum (Al) is bonded through oxygen (O), and thus is electrically neutral. Therefore, the zeolite can hold a cation in its skeleton (backbone). Examples of the cation in the zeolite may include a sodium ion (Na^+). Exchange of the cation may cause an increase in change of the color. Therefore, the zeolite is preferably metal ion-exchanged zeolite. Change in the color can be increased due to exchange of the metal ion. The metal ion may preferably have properties of increasing change in the color. The getter may in particular preferably include copper ion-exchanged zeolite. The copper ion-exchanged zeolite can increase a degree of change in the color. The copper ion-exchanged zeolite is zeolite containing a copper ion. The copper ion can be introduced into the zeolite by cation exchange.

Hereinafter, a method for manufacturing the glass panel unit **10**. FIG. **3** to FIG. **9** show an example of the method for manufacturing the glass panel unit **10**. The glass panel unit **10** shown in FIG. **1** and FIG. **2** can be produced by the method illustrated in FIG. **3** to FIG. **9**.

To produce the glass panel unit **10**, first of all a temporary assembly **100** is prepared as shown in FIG. **3** to FIG. **5** and subsequently a completed assembly **110** shown in FIG. **6** to FIG. **8** is prepared by a predetermined process. Thereafter, as shown in FIG. **9**, the glass panel unit **10** can be obtained by cutting a particular part from the completed assembly **110**.

The method for manufacturing the glass panel unit **10** includes a preparation step, an assembling step, a hermetically enclosing step, and a removing step. Note that, the preparation step can be omitted.

The preparation step is a step of preparing a first glass substrate **200**, a second glass substrate **300**, a frame **410**, a partition **420**, the gas adsorbent **60**, and the multiple spacers **70**. According to the preparation step, an inside space **500**, a gas passage **600**, and an outlet **700** can be formed.

The first glass substrate **200** is a substrate to give the first glass panel **20**. As shown in FIG. **8**, the first glass substrate **200** includes a glass plate **210** determining a plan shape of the first glass substrate **200**, and a coating **220**. The glass plate **210** is a rectangular flate plate and includes a first face and a second face in a thickness direction which are parallel to each other. The coating **220** is formed on the second face of the glass plate **210**. The glass plate **210** forms the body **21** of the first glass panel **20**. The first face of the glass plate **210** corresponds to the first face **21***a* of the body **21**, and the second face of the glass plate **210** corresponds to the second face **21***b* of the body **21**. The coating **220** forms the coating **22** of the first glass panel **20**. Note that, the coating **220** may be optional.

The second glass substrate **300** is a substrate to give the second glass panel **30**. As shown in FIG. **8**, the second glass substrate **300** includes a glass plate **310** determining a plan shape of the second glass substrate **300**. The glass plate **310** is a rectangular flat plate and includes a first face and a second face in a thickness direction which are parallel to each other. The second glass substrate **300** serves as a base for the body **31** of the second glass panel **30**. The first face of the glass plate **310** corresponds to the first face **31***a* of the body **31**, and the second face of the glass plate **310** corresponds to the second face **31***b* of the body **31**. The glass plate **310** has the same plan shape and plan size as the glass plate **210**. In other words, the second glass substrate **300** has the same plan shape as the first glass substrate **200**. Further, the glass plate **310** has the same thickness as the glass plate **210**. The second glass substrate **300** includes the glass plate **310** only. In other words, the glass plate **310** forms the second glass substrate **300** by itself.

The second glass substrate **300** is placed opposite the first glass substrate **200**. In more detail, the first glass substrate **200** and the second glass substrate **300** are arranged so that the second face of the glass plate **210** and the first face of the glass plate **310** face and parallel to each other.

The frame **410** is placed between the first glass substrate **200** and the second glass substrate **300** to hermetically bond the first glass substrate **200** and the second glass substrate **300** to each other. Thereby, as shown in FIG. **5**, the inside space **500** enclosed by the frame **410**, the first glass substrate **200**, and the second glass substrate **300** is formed.

The frame **410** is formed of thermal adhesive (the first thermal adhesive with the first softening point). Examples of the first thermal adhesive may include glass frit. Examples of the glass frit may include low-melting-point glass frit.

Examples of the low-melting-point glass frit may include bismuth-based glass frit, lead-based glass frit, and vanadium-based glass frit.

The frame **410** has a rectangular frame shape. The frame **410** has the same plan shape as each of the glass plates **210** and **310**, but the frame **410** has a smaller plan size than each of the glass plates **210** and **310**. As shown in FIG. **3**, the frame **410** is formed to extend along an outer periphery of the second glass substrate **300**. In other words, the frame **410** is formed to cover an almost entire region on the second glass substrate **300**.

The partition **420** is placed inside the inside space **500**. As shown in FIG. **5**, the partition **420** divides the inside space **500** into an evacuation space **510** and a gas passage space **520**. The evacuation space **510** is a space to be evacuated later, and the gas passage space **520** is a space used for evacuating the evacuation space **510**. The partition **420** is formed between a first end (right end in FIG. **3**) and a center of the second glass substrate **300** in a lengthwise direction (left and right direction in FIG. **3**) of the second glass substrate **300** so that the evacuation space **510** is larger than the gas passage space **520**.

The partition **420** includes a wall part **421** and a pair of closing parts **422** (a first closing part **4221** and a second closing part **4222**). The wall part **421** is formed to extend along a width direction of the second glass substrate **300**. In FIG. **5**, the width direction means a direction extending along a short side of the temporary assembly **100** with a rectangular shape. Note that, the wall part **421** has opposite ends in a lengthwise direction not in contact with the frame **410**. The pair of closing parts **422** extends from the opposite ends in the lengthwise direction of the wall part **421** toward the first end in the lengthwise direction of the second glass substrate **300**.

The partition **420** is formed of thermal adhesive (the second thermal adhesive with the second softening point). Examples of the second thermal adhesive may include glass frit. Examples of the glass frit may include low-melting-point glass frit. Examples of the low-melting-point glass frit may include bismuth-based glass frit, lead-based glass frit, and vanadium-based glass frit. The second thermal adhesive is same as the first thermal adhesive, and the second softening point is equal to the first softening point.

The gas adsorbent **60** is placed inside the evacuation space **510**. In more detail, the gas adsorbent **60** is placed on one end of the evacuation space **510**. Further, the gas adsorbent **60** is positioned away from the partition **420** and the gas passage **600**. Hence, it is possible to lower a probability that the gas adsorbent **60** prevents evacuation of the evacuation space **510**.

The multiple spacers **70** are already described with reference to FIG. **1** and FIG. **2**. As shown in FIG. **3**, the multiple spacers **70** are arranged at predetermined intervals in longitudinal and lateral directions.

The gas passage **600** interconnects the evacuation space **510** and the gas passage space **520** in the inside space **500**. The gas passage **600** includes a first gas passage **610** and a second gas passage **620**. The first gas passage **610** is a space formed between the first closing part **4221** and part of the frame **410** facing the first closing part **4221**. The second gas passage **620** is a space formed between the second closing part **4222** and part of the frame **410** facing the second closing part **4222**. As a result of placing the partition **420** as described above, the gas passage **600** is formed.

The outlet **700** is a hole interconnecting the gas passage space **520** and an outside space. The outlet **700** is used for evacuating the evacuation space **510** by way of the gas passage space **520** and the gas passage **600**. Therefore, the gas passage **600**, the gas passage space **520**, and the outlet **700** constitute an evacuation passage for evacuating the evacuation space **510**. The outlet **700** is formed in the second glass substrate **300** to interconnect the gas passage space **520** and the outside space. In more detail, the outlet **700** is positioned in a corner of the second glass substrate **300**.

The preparation step is performed for the aforementioned members. The preparation step includes first to sixth steps. Note that, the order of the second to sixth steps may be modified.

The first step is a step (substrate formation step) of forming the first glass substrate **200** and the second glass substrate **300**. For example, in the first step, the first glass substrate **200** and the second glass substrate **300** are produced. The first step may include cleaning the first glass substrate **200** and the second glass substrate **300** if necessary.

The second step is a step of forming the outlet **700**. In the second step, the outlet **700** is formed in the second glass substrate **300**. Further, in the second step, the second glass substrate **300** is cleaned if necessary. Note that, the outlet **700** may be formed in the first glass substrate **200**.

The third step is a step (sealing material formation step) of forming the frame **410** and the partition **420**. In the third step, the material (the first thermal adhesive) of the frame **410** and the material (the second thermal adhesive) of the partition **420** are applied on to the second glass substrate **300** (the first face of the glass plate **310**) with a dispenser or the like. Thereafter, the material of the frame **410** and the material of the partition **420** are dried and calcined. For example, the second glass substrate **300** where the material of the frame **410** and the material of the partition **420** are applied is heated at 480° C. for 20 minutes. Note that, the first glass substrate **200** may be heated together with the second glass substrate **300**. In other words, the first glass substrate **200** may be heated under the same condition (at 480° C. for 20 minutes) as the second glass substrate **300**. By doing so, it is possible to reduce a difference in degree of warp between the first glass substrate **200** and the second glass substrate **300**.

The fourth step is a step (spacer formation step) of forming the spacers **70**. The fourth step may include placing the multiple spacers **70** in individual predetermined locations on the second glass substrate **300** with a chip mounter. Note that, the multiple spacers **70** are formed in advance. Alternatively, the multiple spacers **70** may be formed by use of photolithography techniques and etching techniques. In this case, the multiple spacers **70** may be made of photocurable material or the like. Alternatively, the multiple spacers **70** may be formed by use of known thin film formation techniques.

The fifth step is a step (gas adsorbent formation step) of forming the gas adsorbent **60**. In the fifth step, a solution where a power of the getter is dispersed is applied to a predetermined location on the second glass substrate **300** and then dried to thereby form the gas adsorbent **60**.

When a process from the first step to the fifth step is completed, the second glass substrate **300** is obtained, on which the frame **410**, the partition **420**, the gas passage **600**, the outlet **700**, the gas adsorbent **60**, and the multiple spacers **70** are formed as shown in FIG. **3**.

The sixth step is a step (placing step) of placing the first glass substrate **200** and the second glass substrate **300**. In the sixth step, the first glass substrate **200** and the second glass substrate **300** are placed so that the second face of the glass plate **210** and the first face of the glass plate **310** face and are parallel to each other. FIG. **4** shows a step of placing the first glass substrate **200** on the second glass substrate **300**. Note that, in the present example, members (for example, the frame **410** and the partition **420**) are placed on the second glass substrate **300**. Alternatively, such members may be placed on the first glass substrate **200**.

The assembling step is a step of preparing the temporary assembly **100**. In more detail, in the assembling step, the temporary assembly **100** is prepared by bonding the first glass substrate **200** and the second glass substrate **300** to each other. In other words, the assembling step may be referred to as a step (first melting step) of hermetically bonding the first glass substrate **200** and the second glass substrate **300** to each other with the frame **410**.

In the first melting step, the first thermal adhesive is melted once at the predetermined temperature (the first melting temperature) equal to or higher than the first softening point and thereby the first glass substrate **200** and the second glass substrate **300** are hermetically bonded to each other. The first glass substrate **200** and the second glass substrate **300** are hermetically bonded to each other with the frame **410**. In more detail, the first glass substrate **200** and the second glass substrate **300** are placed in a furnace and heated at the first melting temperature only for predetermined time (the first melting time).

The first melting temperature and the first melting time are selected so that the first glass substrate **200** and the second glass substrate **300** are hermetically bonded to each other with the thermal adhesive of the frame **410** but the gas passage **600** is not closed by the partition **420**. In other words, a lower limit of the first melting temperature is equal to the first softening point, and an upper limit of the first melting temperature is however selected so as not to cause the partition **420** to close the gas passage **600**. For example, when the first softening point and the second softening point are 434° C., the first melting temperature is set to 440° C. Further, the first melting time may be 10 minutes, for example. Note that, in the first melting step, the frame **410** may emit gas. However such gas may be adsorbed by the gas adsorbent **60**.

Through the aforementioned assembling step (the first melting step), the temporary assembly **100** shown in FIG. **5** can be produced. The temporary assembly **100** includes the first glass substrate **200**, the second glass substrate **300**, the frame **410**, the inside space **500**, the partition **420**, the gas passage **600**, the outlet **700**, the gas adsorbent **60**, and the multiple spacers **70**.

The hermetically enclosing step is a step of subjecting the temporary assembly **100** to the above predetermined process to obtain the completed assembly **110**. The hermetically enclosing step includes the evacuating step and a melting step (the second melting step). In other words, the evacuating step and the second melting step constitute the above predetermined process.

The evacuating step is a step of converting the evacuation space **510** into the evacuated space **50** by evacuating it by way of the gas passage **600**, the gas passage space **520**, and the outlet **700** at the predetermined temperature (the evacuating temperature).

Evacuation can be done by a vacuum pump, for example. As shown in FIG. **5**, the vacuum pump is connected to the temporary assembly **100** with the evacuation pipe **810** and a sealing head **820**. The evacuation pipe **810** is bonded to the second glass substrate **300** so that an inside of the evacuation pipe **810** is connected to the outlet **700**, for example. The sealing head **820** is attached to the evacuation pipe **810**, and thereby an inlet of the vacuum pump is connected to the outlet **700**.

The first melting step, the evacuating step, and the second melting step are performed with the first glass substrate **200** and the second glass substrate **300** being left in the furnace. In this regard, the frame **410**, the partition **420**, the gas passage **600**, the outlet **700**, the gas adsorbent **60**, and the multiple spacers **70** are already provided to the second glass substrate **300**. Therefore, an evacuation pipe **810** is bonded to the second glass substrate **300** before the first melting step at the latest.

In the evacuating step, the evacuation space **510** is evacuated by way of the gas passage **600**, the gas passage space **520**, and the outlet **700** at a predetermined evacuating temperature only for predetermined time (evacuation time). The evacuating temperature is set to be higher than the activation temperature (for example, 350° C.) of the getter of the gas adsorbent **60**, and also is set to be lower than the first softening point and the second softening point (for example, 434° C.). For example, the evacuating temperature is 390° C. According to the above settings, deformation of the frame **410** and the partition **420** is unlikely to occur. Further, the getter of the gas adsorbent **60** is activated, and thus molecules (gas) adsorbed on the getter are desorbed from the getter. Such molecules (that is, gas) desorbed from the getter are discarded through the evacuation space **510**, the gas passage **600**, the gas passage space **520**, and the outlet **700**. Therefore, in the evacuating step, the adsorbability of the gas adsorbent **60** is recovered. The evacuation time is set to obtain the evacuated space **50** having a desired degree of vacuum (for example, a degree of vacuum equal to or lower than 0.1 Pa). For example, the evacuation time is set to 120 minutes.

The second melting step is a step of forming the seal **40** enclosing the evacuated space **50** by changing the shape of the partition **420** to form the separator **42** closing the gas passage **600**. In the second melting step, the second thermal adhesive is melted once at the predetermined temperature (the second melting temperature) equal to or higher than the second softening point, and thereby the partition **420** is changed in shape to form the separator **42**. In more detail, the first glass substrate **200** and the second glass substrate **300** are heated at the second melting temperature for the predetermined time (the second melting time) in the furnace.

The second melting temperature and the second melting time are set to allow the second thermal adhesive to soften to form the separator **42** closing the gas passage **600**. A lower limit of the second melting temperature is equal to the second softening point (434° C.). Note that, differently from the first melting step, the purpose of the second melting step is to change the shape of the partition **420**, and consequently the second melting temperature is set to be higher than the first melting temperature (440° C.). For example, the second melting temperature is set to 460° C. Additionally, the second melting time is, for example, 30 minutes.

When the separator **42** is formed, the evacuated space **50** is separated from the gas passage space **520**. Hence, the vacuum pump cannot evacuate the evacuated space **50**. The frame **410** and the separator **42** are heated until the second melting step is finished, and therefore gas may be emitted from the frame **410** and the separator **42**. However, gas emitted from the frame **410** and the separator **42** is adsorbed on the gas adsorbent **60** inside the evacuated space **50**. Consequently, a decrease in the degree of vacuum of the evacuated space **50** can be suppressed. In summary, it is possible to suppress a decrease in the thermal insulating properties of the glass panel unit **10**.

Also in the first melting step, the frame **410** and the separator **42** are heated. Thus, the frame **410** and the separator **42** may emit gas. Gas emitted by the frame **410** and the separator **42** is adsorbed by the gas adsorbent **60**, and therefore the adsorbability of the gas adsorbent **60** may decrease due to the first melting step. However, in the evacuating step, the evacuation space **510** is evacuated at the evacuating temperature equal to or higher than the activation temperature of the getter of the gas adsorbent **60** and thereby the adsorbability of the gas adsorbent **60** is recovered. Therefore, the gas adsorbent **60** can adsorb a sufficient amount of gas emitted from the frame **410** and the separator **42** in the second melting step. In other words, it is possible to avoid an undesired situation the gas adsorbent **60** fails to adsorb a sufficient amount of gas emitted from the frame **410** and the separator **42** and thus the degree of vacuum of the evacuated space **50** decreases.

Additionally, in the second melting step, evacuation of the evacuation space **510** through the gas passage **600**, the gas passage space **520**, and the outlet **700** is continued from the evacuating step. In other words, in the second melting step, the separator **42** closing the gas passage **600** is formed by changing the shape of the partition **420** at the second melting temperature while the evacuation space **510** is evacuated through the gas passage **600**, the gas passage space **520**, and the outlet **700**. By doing so, it is possible to more lower a probability that the degree of vacuum of the evacuated space **50** decreases during the second melting step. Note that, the second melting step does not necessarily include evacuating the evacuation space **510** through the gas passage **600**, the gas passage space **520**, and the outlet **700**.

The above predetermined process includes converting the evacuation space **510** into the evacuated space **50** by evacuating the evacuation space **510** by way of the gas passage **600**, the gas passage space **520**, and the outlet **700** at a predetermined temperature (evacuating temperature). The evacuating temperature is higher than the activation temperature of the getter of the gas adsorbent **60**. Consequently, evacuation of the evacuation space **510** and recovery of the adsorbability of the getter can be performed simultaneously.

The above predetermined process further includes forming the seal **40** enclosing the evacuated space **50** by forming a separator **42** for closing the gas passage **600** by changing a shape of the partition **420** (see FIG. **7**). The partition **420** includes the second thermal adhesive. Therefore, the separator **42** can be formed by changing the shape of the partition **420** by once melting the second thermal adhesive at a predetermined temperature (second melting temperature) equal to or higher than the second softening point. Note that, the first melting temperature is lower than the second melting temperature. Consequently, it is possible to prevent the gas passage **600** from being closed due to deformation of the partition **420** in bonding the first glass substrate **200** and the second glass substrate **300** with the frame **410**. Note that, the partition **420** may be made of material which is more deformable than that of the frame **410** when melted.

The partition **420** is changed in shape so that the first closing part **4221** closes the first gas passage **610** and the second closing part **4222** closes the second gas passage **620**. The separator **42**, which is obtained by changing the shape of the partition **420** as described above, separates (spatially) the evacuated space **50** from the gas passage space **520**. The separator (second part) **42** and part (first part) **41** of the frame **410** corresponding to the evacuated space **50** constitute the seal **40** enclosing the evacuated space **50**.

The evacuated space **50** is obtained by evacuating the evacuation space **510** by way of the gas passage space **520** and the outlet **700** as described above. The evacuated space **50** is hermetically enclosed by the first glass substrate **200**, the second glass substrate **300**, and the seal **40** completely and thus is separated from the gas passage space **520** and the outlet **700**.

Additionally, the seal **40** with a rectangular frame shape is formed. The seal **40** includes the first part **41** and the second part **42**. The first part **41** is part of the frame **410** corresponding to the evacuated space **50**. In other words, the first part **41** is part of the frame **410** facing the evacuated space **50**. The first part **41** has an almost U-shape, and serves as three of four sides of the seal **40**. The second part **42** is a separator formed by changing the shape of the partition **420**. The second part **42** has an I-shape, and serves as a remaining one of the four sides of the seal **40**.

Through the aforementioned hermetically enclosing step, the completed assembly **110** shown in FIG. **6** to FIG. **8** is produced. The completed assembly **110** includes the first glass substrate **200**, the second glass substrate **300**, the seal **40**, the evacuated space **50**, the gas passage space **520**, the gas adsorbent **60**, and the multiple spacers **70**. Note that, in FIG. **7**, to facilitate understanding of the internal structure only, the first glass substrate **200** is illustrated with part (right and lower part) thereof being cutaway.

The removing step is a step of obtaining the glass panel unit **10** which is part including the evacuated space **50**, by removing part **11** including the gas passage space **520** from the completed assembly **110**. As shown in FIG. **7**, in more detail, the completed assembly **110** taken out from the furnace is cut along the cutting line **900**, and thereby is divided into predetermined part (glass panel unit) **10** including the evacuated space **50** and part (unnecessary part) **11** including the gas passage space **520**. The unnecessary part **11** mainly includes part **230** of the first glass substrate **200** corresponding to the gas passage space **520**, part **320** of the second glass substrate **300** corresponding to the gas passage space **520**, and part **411** of the frame **410** corresponding to the gas passage space **520**. Note that, in consideration of production cost of the glass panel unit **10**, the unnecessary part **11** is preferably as small as possible. FIG. **9** shows removing the unnecessary part **11** from the completed assembly **110**.

Cutting is done by an appropriate cutting device. Examples of the cutting device may include a scriber and a laser. By cutting the first glass substrate **200** and the second glass substrate **300** at the same time, the glass panel unit **10** can be cut efficiently. Note that, the shape of the cutting line **900** is set according to the shape of the glass panel unit **10**. The glass panel unit **10** is rectangular, and therefore the cutting line **900** is a straight line along the lengthwise direction of the wall separator **42**.

Through the aforementioned preparation step, assembling step, hermetically enclosing step, and removing step, the glass panel unit **10** as shown in FIG. **1** and FIG. **2** is produced. The first glass panel **20** is part of the first glass substrate **200** corresponding to the evacuated space **50**. The second glass panel **30** is part of the second glass substrate **300** corresponding to the evacuated space **50**. The outlet **700** for forming the evacuated space **50** is present in the part **320** of the second glass substrate **300** corresponding to the gas passage space **520**, and the evacuation pipe **810** is connected to the part **320**. Therefore, the outlet **700** is not present in the second glass panel **30**.

An inspection method of glass panel unit is described with reference to the glass panel unit **10** and the method for manufacturing the same which are described above.

The inspection method of the glass panel unit **10** includes determining the degree of vacuum of the evacuated space **50**. As described above, the gas adsorbent **60** has properties of changing its color when adsorbing gas. Therefore, an activation state of the gas adsorbent **60** can be checked based on the color thereof. When the gas adsorbent **60** is less active, the degree of vacuum can be determined low. When the gas adsorbent **60** is kept active, the degree of vacuum can be determined high.

The inspection method of glass panel unit allows determining the degree of vacuum of the evacuated space **50** of the glass panel unit **10** even after manufacturing thereof. In manufacturing, it is possible to inspect whether the vacuum state is maintained. For example, after manufacturing the glass panel unit **10**, the color of the gas adsorbent **60** is checked. When the color of the gas adsorbent **60** is changed from its original color, it can be inferred that the gas adsorbent **60** has adsorbed gas inside the evacuated space **50** and thus there may be gas inside the evacuated space **50**. In this case, it can be determined that the degree of vacuum of the evacuated space **50** is low and thus the vacuum state of the evacuated space **50** is not maintained. The glass panel unit **10** does not have enough thermal insulating properties due to a lack of vacuum and therefore is considered a defective product. In contrast, when the color of the gas adsorbent **60** is identical to its original color, gas is inferred to not exist or not substantially exist inside the evacuated space **50**. In this case, it can be determined that the degree of vacuum of the evacuated space **50** is kept high and thus the evacuated space **50** is in the vacuum state. Accordingly, the glass panel unit **10** has thermal insulating properties due to presence of vacuum and therefore is considered a non-defective product. The inspection method of the glass panel unit **10** may be included as one step in the method for manufacturing the glass panel unit **10**.

After manufacturing the glass panel unit **10**, in some cases the seal **40** may not be stable yet and thus discharge gas. If airtightness of the seal **40** is insufficient, external air is likely to intrude into the evacuated space **50** through a gap between the seal **40** and a glass panel. After manufacturing, the seal **40** may shrink to form a gap. Even in those cases, the above inspection method allows facilitating check of the degree of vacuum. Such a leakage can be checked based on change in color of the gas adsorbent.

The color change of the gas adsorbent **60** may be checked with the naked eyes or by optical means such as color difference measurement and chromaticity measurement. When such check can be done with the naked eyes, the inspection becomes easy. When the color change is checked with an optical measurement device, it can be determined precisely. For example, when there is a large change in the color difference of the gas adsorbent **60**, check of the color change becomes easy. Based on the color change of the gas adsorbent **60**, deactivation of the gas adsorbent **60** can be checked.

An actual example of the color change of the gas adsorbent **60** is shown. FIG. **10** is a photograph illustrating one example of the color change of the gas adsorbent **60**. The getter is a copper ion-exchanged zeolite. To observe changes in color, the gas adsorbents **60** are provided to a surface of a glass panel. The gas adsorbent **60**R shown in the right side does not show change in its color (actually, the gas adsorbent **60**R has a bluish color). Hence, the gas adsorbent **60**R is kept active. In contrast, the gas adsorbent **60**L shown in the left side shows a change in its color (actually, the gas adsorbent **60**L has a reddish color). The gas adsorbent **60**L had its original color identical to the color of the gas adsorbent **60**R on the right side. However, the gas adsorbent **60**L adsorbed a saturation amount of gas, and thus became inactive to have its color changed. The monochrome shows only a change in a gray value, but actually there is change in a color tone. It is preferable that change in the color be larger. In this actual example, the gas adsorbent **60**L shows change in chromaticity before and after change in the color.

The inspection method of the glass panel unit **10** allows determining the degree of vacuum of the evacuated space **50** of the glass panel unit **10** even after a lapse of a predetermined time period. For example, it is possible to determine whether the vacuum state of the glass panel unit **10** is maintained even after it is stored for a predetermined time period. This inspection method can apply to custody of inventory. Additionally, for example, it is possible to check whether the vacuum state is maintained after use of the glass panel unit **10** as a product. In a concrete example, it is possible to check the degree of vacuum of the glass panel unit **10** which is already used as a window.

The glass panel unit **10** can facilitate check of the degree of vacuum based on change in color. It is difficult to check the degree of vacuum of the glass panel unit **10** hermetically enclosed with conventional techniques. For example, there may be a method including inspecting the thermal insulating properties of the glass panel unit to check whether the degree of vacuum is maintained. As for intrusion (leakage) through a gap in the seal **40**, check may be done by detecting colored gas intruding. However, these inspection methods are complex and not easy. In contrast, according to the above inspection method of the glass panel unit **10**, it is possible to check the degree of vacuum precisely and easily based on change in the color. As apparent from the above, the inspection method of the glass panel unit **10** allows easily determining the degree of vacuum of the evacuated space **50** based on change in the color. Therefore, it is possible to check whether the vacuum state is maintained, and therefore the glass panel unit **10** maintaining the vacuum state can be provided.

Note that, in the above embodiment, the gas adsorbent **60** is linear, but the gas adsorbent **60** may have an appropriate shape. For example, the gas adsorbent **60** may have a shape representing one or more letters and symbols. In a concrete example, the gas adsorbent **60** may have a shape representing a logo. For example, the word "NG" and the symbol "x" may become visible when change in color has occurred. In this case, it is possible to easily understand that there is defect, and check can be facilitated. Especially, the meaning appearing in response to change in color can be easily understood, and therefore customers and users can easily make determination.

Hereinafter, optional modifications relating to the glass panel unit are described. In the description relating to the modifications, the reference sings in parentheses of corresponding components are introduced.

In the above embodiment, the glass panel unit (**10**) is rectangular, but the glass panel unit (**10**) may have a desired shape such as a circular shape and a polygonal shape. Stated differently, each of the first glass panel (**20**), the second glass panel (**30**), and the seal (**40**) may not be rectangular and may have a desired shape such as a circular shape and a polygonal shape. Note that, the shapes of the first glass substrate (**200**), the second glass substrate (**300**), the frame (**410**), and, the separator (**42**) may not be limited to the shapes described in the explanation of the above embodiment, and may have such shapes that the glass panel unit (**10**) can have a desired shape. Note that, the shape and size of the glass panel unit (**10**) may be determined in consideration of application of the glass panel unit (**10**).

Additionally, the first face and the second face, of the body (**21**) of the first glass panel (**20**) may not be limited to flat faces. Similarly, the first face and the second face, of the body (**31**) of the second glass panel (**30**) may not be limited to flat faces.

Additionally, the body (**21**) of the first glass panel (**20**) and the body (**31**) of the second glass panel (**30**) may not have the same plan shape and plan size. Further, the body (**21**) and the body (**31**) may not have the same thickness. Furthermore, the body (**21**) and the body (**31**) may not be made of the same material. Similarly, the glass plate (**210**) of the first glass substrate (**200**) and the glass plate (**310**) of the second glass substrate (**300**) may not have the same plan shape and plan size. Further, the glass plate (**210**) and the glass plate (**310**) may not have the same thickness. Furthermore, the glass plate (**210**) and the glass plate (**310**) may not be made of the same material.

Additionally, the seal (**40**) may not have the same plan shape with the first glass panel (**20**) and the second glass panel (**30**). Similarly, the frame (**410**) may not have the same plan shape with the first glass substrate (**200**) and the second glass substrate (**300**).

Additionally, the first glass panel (**20**) may include a coating which has desired physical properties and is formed on the second face of the body (**21**). Alternatively, the first glass panel (**20**) may not include the coating (**22**). In other words, the first glass panel (**20**) may be constituted by the body (**21**) only.

Additionally, the second glass panel (**30**) may include a coating with desired physical properties. For example, the coating may include at least one of thin films formed on the first face and the second face of the body (**31**) respectively. Examples of the coating may include a film reflective for light with a specified wavelength (for example, infrared reflective film and ultraviolet reflective film).

In the above embodiment, the frame (**410**) is made of the first thermal adhesive. However, the frame (**410**) may include other component such as a core, in addition to the first thermal adhesive. Stated differently, it is sufficient that the frame (**410**) includes the first thermal adhesive. In the above embodiment, the frame (**410**) is formed to surround an almost entire region on the second glass substrate (**300**). However, it is sufficient that the frame (**410**) is formed to surround a predetermined region on the second glass substrate (**300**). In other words, there is no need to form the frame (**410**) so as to surround an almost entire region on the second glass substrate (**300**). Alternatively, the completed assembly (**110**) may include two or more frames (**410**). In other words, the completed assembly (**110**) may include two or more inside spaces (**500**). In this case, it is possible to produce two or more glass panel units (**10**) from one completed assembly (**110**).

In the above embodiment, the partition (**420**) is made of the second thermal adhesive. However, the partition (**420**) may include other component such as a core, in addition to the second thermal adhesive. Stated differently, it is sufficient that the partition (**420**) includes the second thermal adhesive. Further, in the above embodiment, the partition (**420**) has its opposite end not connected to the frame (**410**). And, gaps between the opposite ends of the partition (**420**) and the frame (**410**) define the gas passages (**610**, **620**). However, the partition (**420**) may have only one of its opposite ends not connected to the frame (**410**). In this case, there is one gas passage (**600**) between the partition (**420**) and the frame (**410**). Alternatively, the partition (**420**) may have its opposite end both connected to the frame (**410**). In this case, the gas passage (**600**) may be a through hole formed in the partition (**420**). Alternatively, the gas passage (**600**) may be a gap between the partition (**420**) and the first glass substrate (**200**). Alternatively, the partition (**420**) may be defined as a set of two or more partitions spaced from each other. In this case, the gas passage (**600**) may be a gap between adjacent two of the two or more partitions.

In the above embodiment, the inside space (**500**) is divided into one evacuation space (**510**) and one gas passage space (**520**). Note that, the inside space (**500**) may be divided into one or more evacuation spaces (**510**) and one or more gas passage spaces (**520**). When the inside space (**500**) includes two or more evacuation spaces (**510**), it is possible to produce two or more glass panel units (**10**) from one completed assembly (**110**).

In the above embodiment, the second thermal adhesive is identical to the first thermal adhesive, and the second softening point is equal to the first softening point. However, the second thermal adhesive may be different material from the first thermal adhesive. For example, the second thermal adhesive may have the second softening point different from the first softening point of the first thermal adhesive. In such a case, the second softening point may be preferably higher than the first softening point. In this case, the first melting temperature can be set to be equal to or higher than the first softening point and lower than the second softening point. By doing so, it is possible to suppress undesired deformation of the partition **420** in the first melting step.

Additionally, each of the first thermal adhesive and the second thermal adhesive may not be limited to glass frit, but may be selected from low-melting-point metal, hot-melt adhesive, and the like, for example.

In the above embodiment, a furnace is used to heat the frame (**410**), the gas adsorbent (**60**), and the partition (**420**). However, such heating can be done with appropriate heating means. Examples of the heating means may include a laser and a thermally conductive plate connected to a heat source.

In the above embodiment, the gas passage (**600**) includes the two gas passages (**610**, **620**). However, the gas passage (**600**) may include only one gas passage or may include three or more gas passages. Further, the shape of the gas passage (**600**) may not be limited in particular.

In the above embodiment, the outlet (**700**) is formed in the second glass substrate (**300**). However, the outlet (**700**) may be formed in the glass plate (**210**) of the first glass substrate (**200**) or may be formed in the frame (**410**). In summary, the outlet (**700**) may be allowed to be formed in the unnecessary part (**11**).

In the above embodiment, the getter of the gas adsorbent (**60**) is an evaporative getter. However, the getter may be a non-evaporative getter. When the non-evaporative getter has a temperature equal to or higher than a predetermined temperature (the activation temperature), adsorbed molecules intrudes into an inside of the getter, and thus the adsorbability can be recovered. In contrast to the evaporative getter, the adsorbed molecules are not desorbed. Therefore, after the non-evaporative getter has adsorbed an amount of molecules equal to or more than a certain amount, the adsorbability is no longer recovered even if the getter is heated up to a temperature equal to or higher than the activation temperature.

In the above embodiment, the gas adsorbent (**60**) has an elongated shape, but may have another shape. Additionally, the gas adsorbent (**60**) may not be necessarily positioned at the end of the evacuated space (**50**). Further, in the above embodiment, the gas adsorbent (**60**) may be formed by applying a liquid containing a powder of the getter (for example, a dispersion liquid prepared by dispersing a powder of the getter in a liquid, and a solution prepared by dissolving a powder of the getter in a liquid). However, the gas adsorbent (**60**) may include a substrate and the getter fixed to the substrate. This type of the gas adsorbent (**60**) may be formed by immersing a substrate in a liquid containing the getter and drying it. Note that, the substrate may have a desired shape, but may be an elongated rectangular shape, for example.

Alternatively, the gas adsorbent (**60**) may be a film formed entirely or partially on the surface (first face) of the glass plate (**310**) of the second glass substrate (**300**). This type of the gas adsorbent (**60**) may be formed by coating the surface (first face) of the glass plate (**310**) of the second glass substrate (**300**) with a liquid containing a powder of the getter.

Alternatively, the gas adsorbent (**60**) may be included in the spacer (**70**). For example, the spacer (**70**) may be made of material containing the getter, and thereby the spacer (**70**) including the gas adsorbent (**60**) can be obtained.

Alternatively, the gas adsorbent (**60**) may be solid material made of the getter. This gas adsorbent (**60**) tends to have a large size, and thus cannot be placed between the first glass substrate (**200**) and the second glass substrate (**300**) in some cases. In such cases, the glass plate (**310**) of the second glass substrate (**300**) may be formed to include a recess, and the gas adsorbent (**60**) may be placed in this recess.

Alternatively, the gas adsorbent (**60**) may be preliminarily placed in a package to suppress the getter from adsorbing molecules. In this case, the package may be broken after the second melting step to expose the gas adsorbent (**60**) to the evacuated space (**50**).

In the above embodiment, the glass panel unit (**10**) includes the multiple spacers (**70**). However, the glass panel unit (**10**) may include a single spacer (**70**). Alternatively, the glass panel unit (**10**) may not include any spacer (**70**).

The present embodiment relates to forming the glass panel unit (**10**) not including an outlet by removing the unnecessary part (**11**). In one case, the glass panel unit (**10**) may include an outlet. In this case, at least one of the first glass panel (**20**) and the second glass panel (**30**) may include an outlet. The outlet is closed to keep the evacuated space (**50**) in the vacuum state. When at least one of the first glass panel (**20**) and the second glass panel (**30**) includes such an outlet, the outlet may be closed with a cap. However, to improve an appearance, it is preferable that the glass panel unit (**10**) do not include the outlet.

The invention claimed is:

1. An inspection method for a glass panel unit comprising a first glass panel;

a second glass panel placed opposite the first glass panel;

a seal with a frame shape placed between the first glass panel and the second glass panel to hermetically bond the first glass panel and the second glass panel to each other;

an evacuated space enclosed by the first glass panel, the second glass panel, and the seal; and

a gas adsorbent placed in the evacuated space and including a getter, the gas adsorbent being visible through at least one of the first glass panel and the second glass panel, and having properties of changing its color when adsorbing gas, the inspection method comprising steps of:

observing an original color of the gas adsorbent at a first time when the gas adsorbent is first placed into the evacuated space through at least one of the first and second glass panels;

observing a color of the gas adsorbent at a second time through at least one of the first and second glass panels, wherein the second time is after the first time by a predetermined time period; and

determining a degree of vacuum of the evacuated space to be low and the gas adsorbent to be inactive when the color of the gas adsorbent at the second time is changed from the original color at the first time.

2. The inspection method of claim **1**, wherein the degree of vacuum of the evacuated space is determined to be lower than 0.1 Pa when the color of the gas adsorbent at the second time is changed from the original color at the first time.

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